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NASA TECH BRIEF

Circuit Modification Aids in Atomic Particle Discrimination

A simple, inexpensive modification of an existing scheme for particle identification has been developed. Fast neutrons and gamma rays incident upon a liquid scintillator cause recoil protons, alpha particles and Compton electrons to be produced. These ionizing particles produce light (low energy photons) with a unique time distribution L(t) for each particle. Many

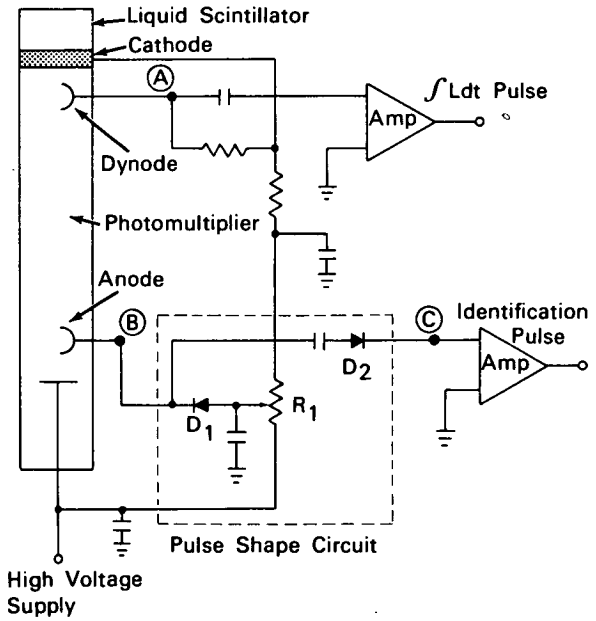

Figure 1A. Proton, Electron, and Alpha Particle Discrimination System

complicated circuits have been devised which analyze L(t) in order to identify the particles. The simplest of these is the Owen circuit which utilizes the nonlinearity of space charge accumulated in the photomultiplier to separate the various L(t) dependences. However, this circuit has several disadvantages:

1. When the last dynode swings positive, there is too much jitter to make the dynode an effective gate pulse for the total light pulse ($\int$Ldt).
2. Large negative pulses at the dynode cause amplifier overload and recovery problems.

These disadvantages have been eliminated by the circuit shown in the figure.

Using a bialkali photomultiplier tube and liquid scintillator, this circuit can distinguish between recoil protons (energies of 200 keV) and Compton electrons (energies of 20 keV). Both events produce

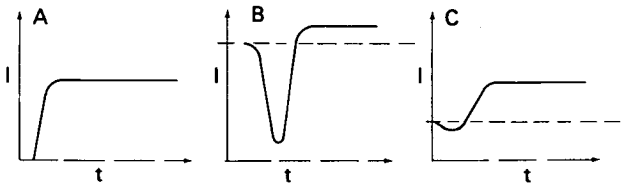

Figure 1B. Pulse Waveforms

the same amount of light, but a larger fraction of the light from the electron is in the fast decay component. The voltage difference between the anode and the last dynode (R_1) is adjusted so that space charge saturation occurs for the fast component. At the last dynode, a negative voltage is produced initially and a positive voltage is produced for the long light component, which occurs after the space charge condition has passed. The diodes, D_1 and D_2, improve circuit performance by reducing the jitter as the dynode pulse goes positive and by eliminating the large negative pulses from the amplifier.

The best separation of neutrons and gamma rays is obtained when the two pulses are fed into a two-dimensional analyzer where the neutron interactions

(continued overleaf)

that produce recoil protons can be separated from those that produce alpha particles.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

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Patent status:

No patent action is contemplated by NASA.

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